HIGHWAY RESEARCH BOARD
DIVISION OF ENGINEERING AND INDUSTRIAL RESEARCH
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Wartime Road Problems

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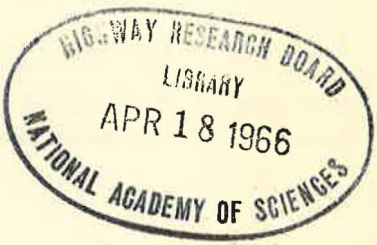
No. 9

RECOMMENDED PRACTICE FOR TREATMENT OF ICY PAVEMENTS



HIGHWAY RESEARCH BOARD
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HIGHWAY RESEARCH BOARD

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Wartime Road Problems

There are two major wartime road responsibilities; to keep the traffic essential to the war effort moving, and to carry the existing roads through the war period in as good condition as possible. Discharge of these responsibilities entails consideration of many new factors in view of the limitations on time, money, labor, equipment and use of critical materials imposed by the exigencies of the national situation. Obviously, changing emphasis from devising better and more economical methods to a program, within the wartime limitations of wartime traffic movement and conservation of the existing roads confronts highway engineers with many new problems and new aspects of old problems.

The Highway Research Board believes that it can be helpful by aiding in disseminating in usable form the best available information on those phases of highway technology in which common practice has not become established or in which practice must be modified during the war. To this end a series of bulletins on WARTIME ROAD PROBLEMS will be prepared by qualified committees and published by the Highway Research Board. Recommendations in this series of bulletins are based upon wartime restrictions and needs and are only intended for use as guides during the periods in which these conditions prevail.

This program has been endorsed by the Executive Committee of the American Association of State Highway Officials.

Suggestions for suitable subjects will be welcomed.

The following report on treatment of icy pavements is of immediate importance. The recommendations, however, are general and need not be restricted to wartime practice as they are applicable whenever the described conditions prevail.

RECOMMENDED PRACTICE FOR TREATMENT OF ICY PAVEMENTS

Prompt removal of snow from the surface of those roads on which the volume and type of traffic warrant this treatment is the winter maintenance policy of most State highway departments.

Since it is almost impossible to plow the pavement bare, the thin layer of packed snow will often glaze over and cause an icy condition similar to that produced by sleet or freezing rain. Ice which forms on the pavement must be treated in some way to prevent skidding. The application of abrasive material either alone or in combination with calcium or sodium chloride is the most common method of treatment. In some cases sodium or calcium chloride is applied without abrasives. The pavement should be treated whenever slippery conditions exist and for as long a period as necessary. On primary roads all grades, curves, intersections and other danger points should be treated immediately after icy conditions develop. If labor, equipment and material are available it is advisable to treat the entire lengths of the more important primary roads. If the abrasives whip off, the road should be re-treated as often and for as long as the slippery conditions exist. The attempt should be made to avoid decreasing the service given the public on the primary roads. Adequate treatment of icy pavements is sound economy.

On secondary and tertiary roads the amount of ice treatment to be undertaken depends upon the importance of the route, the geographic location and the type of traffic. On secondary routes it is advisable to apply abrasives on steep grades, sharp curves and other danger points. On roads where traffic is light it may be possible to use untreated abrasives. Ice treatment of tertiary and other less important roads is a local problem and should be handled according to the needs of existing conditions.

MATERIALS

Calcium Chloride

Calcium chloride should conform to the requirements of the American Society for Testing Material Standard Specification Calcium Chloride, Designation D 98.

Sodium Chloride

Sodium chloride should conform to th quirements of the American Society for ing Materials Tentative Specification Sodium Chloride, Designation D 632.

Abrasives

Local availability and unit cost dete the type of abrasive to be used. The c labor and equipment for storing and app abrasives is several times that of the ma itself. Thus a small initial saving in ma cost might be more than offset by the nec for larger quantities of abrasives per s yard or more frequent applications.

Sand: Sand containing an excess of does not provide good traction, and material is likely to whip off and is the not effective in combating the skid ha Sand for ice control should be clean, sharp, and free from loam, clay, or f lumps, with 100 per cent passing a $\frac{3}{8}$-in. not less than 45 per cent passing a N sieve, and not more than 30 per cent pas No. 50 sieve. This sand will provide traction and will have very little grinding on the road surface.

Cinders: Cinders are sharper than san cling to tires and cut into ice better than particles. The melting or embedding a of cinders with their greater porosity is than that of sand because of the larger tity of moisture and chloride held at or n surface of the cinder particles. Due to dark color cinders absorb more heat than when the sun is shining, which resul greater embedment. Also, cinders hav tendency to clog drainage structures.

Washed Stone Screenings: Stone scree from which the fines have been remove washing produce a good abrasive; 100 per should pass the $\frac{3}{8}$-in. sieve, with not less 45 per cent passing a No. 16 sieve an more than 30 per cent passing a No. 50

The percentage of wear of crushed rock

hich screenings for abrasives are prepared ould not be more than 45 per cent as de- rmined by the Standard Method of Test for brasion of Coarse Aggregate by the Use of e Los Angeles Machine (American Associa- on of State Highway Officials T96-42; merican Society for Testing Materials 131-39).

TREATMENT OF ABRASIVES

Abrasives should be treated to prevent eezing before application and as an aid to em- dding the material in the ice or packed snow that it will not be blown off the road. eating the abrasives, does not work out well practice. Treatment with sodium or cal- um chloride is the best method of preparing brasives for treating icy pavements.

Experience has shown that on heavily- aveled highways untreated abrasives whip f the road and that even moderate winds will eep the material from the surface. Only on ght traffic roads or streets free from wind is it ssible to keep the abrasives on the road ithout the addition of chemicals.

reatment with Dry Calcium or Sodium Chloride

When abrasives are placed in storage they ould be treated with from 40 to 75 lbs. of loride per cubic yard depending on the oisture content of the abrasive and the mperature. For sand and stone screenings ntaining not more than 4 per cent of oisture, 40 lb. is recommended; for sand and one screenings with moisture contents, eater than 4 per cent and for all cinder ab- sives 75 lb. is recommended. The protec- on provided by these amounts of calcium or dium chloride will assure unfrozen material own to zero temperature for even a combina- on of cinder abrasives with 15 per cent oisture.

The chloride should be well mixed with the brasive by some practical method at nominal st. The chloride may be ribboned in with e abrasive as it is being loaded into bins, or it ay be spread over each load as it is discharged to stockpiles. The chloride will gradually ssolve and disperse in the moisture present the abrasive.

When the trucks are loaded for distribution the abrasive on the road additional chloride ay be added. This additional treatment (usually 25 to 50 lb. per cu. yd.) provides a reserve melting capacity which accelerates the embedment of the abrasive into the icy surface, thus minimizing loss due to traffic and wind. When abrasives are stored in covered water-tight bins, it is possible to use considerably less chloride as loss from dilution and leaching is prevented. In such cases, if the chloride is uniformly distributed with the aggregate, it will not be necessary to add chloride when loading trucks from the material in storage.

CALCIUM CHLORIDE BRINE SPRAY METHOD

A convenient and efficient method of applying calcium chloride to the abrasive to obtain quick and uniform dispersal of the chemical is by spraying with brine. The brine is usually made up of 5 lb. of flake calcium chloride to 1 gal. of water. The resultant brine will contain 4 lb. of chloride per gallon, which is the eutectic or lowest freezing point solution.

A practical way to prepare such a solution is to fill a 50 gal. drum about two-thirds full of water (never add the calcium chloride first), then put in 200 lb. of dry flake calcium chloride, stir until it is dissolved and fill with water to the top.

The brine treatment provides a saturated unfrozen condition of the abrasive which considerably hastens the solution of any additional flake chloride required. The method is especially adapted to use with cinders or other high absorptive abrasives which may be received comparatively dry. The amount of chloride, applied in brine, which can be held by the abrasive without loss from drainage is controlled by the moisture content of the abrasive as received. The saturation point of average sand is about 18 gal. per cu. yd. The brine can be absorbed without loss of chloride until the total moisture and brine content reaches the saturation point.

Dry or Damp Sand or Stone Screenings

With these materials it is generally possible to use about 8 gal. of brine per cubic yard of abrasive with a negligible loss of chloride. The operator, after a few initial tests and trials, learns to soak the abrasive without over-saturation. The brine is usually sprayed on

the abrasive as it is being loaded into bins or into covered stockpiles. Eight gallons of brine introduces about 32 lb. of chloride to 1 cu. yd. of abrasive. This amount is sufficient for pretreatment to prevent freezing in the bins and for use on the road at temperatures down to about 20°F. For lower temperatures, it becomes necessary to add additional flake chloride as given in Table 1.

TABLE 1.—(BASED ON TOTAL ABSORPTION OF 18 GAL. PER CU. YD.)

A	B	C	D	E
6	24	16	26	36
8	32	8	18	28
10	40	0	10	20
12	48	0	2	12

A—gallons of brine used per cubic yard of abrasive.
B—pounds of chloride per cubic yard of abrasive introduced.
C—pounds of flake chloride per cu. yd. in addition to Column B required for +10°F.
D—pounds of flake chloride per cu. yd. in addition to Column B required for −5°F.
E—pounds of flake chloride per cu. yd. in addition to Column B required for −20°F.

Dry or Damp Cinders

With dry or damp cinders, it is necessary on account of the greater absorption to use 15 to 20 gal. of the brine per cubic yard of abrasive.

Wet Sand, Stone Screenings or Cinders

If the sand, stone screenings or cinders are more than damp the brine spray method is not recommended. However, if its use is necessary with wet sand or screenings, add only enough brine to assure saturation and then supplement this with dry flake calcium chloride.

For example, if the brine application only provides 24 lb. of calcium chloride per cubic yard of abrasive, whereas for −5°F. a total of 50 lb. is required, it will be necessary to make up the deficiency by adding 26 lb. additional flake calcium chloride per cubic yard. The operator after a few tests and trials learns to soak the abrasive without over-saturation and loss of chloride from drainage.

SODIUM CHLORIDE BRINE SPRAY METHOD

Sodium chloride may be used in the form of a brine spray as described for calcium chloride, except that it is not recommended for use in climates or during seasons when tempera below zero Fahrenheit might be encoun

STORAGE OF ABRASIVES

Bins

The best method of storing abrasives bins so located that they will serve more one road if possible. A bin to be use ficiently should be accessible at two eleva one at an upper level so that trucks can charge into the bin and the other on a level so that trucks can be loaded direct gravity. The capacity should be 50 to 1 yd. depending on the needs of the roads served.

Sheds

When storage is required at a location does not have the necessary difference in vation for a bin, a shed gives the next protection for treated abrasives. A should have a capacity of at least 100 cu and so built that the walls will suppor load of the sand piled against them. It sh be enclosed on three sides and roofed belt or bucket-type loader should be prov

Stockpiles

Where it is not possible to have either or shed, the abrasives should be placed stockpile. Such a pile should have a angular cross section about 6 ft. high and wide at the base. It is desirable to cover piles with waterproof paper. Howeve such paper is practically unobtainable d the war, use will have to be made of any stitutes that may be available. The d of protection will depend upon the water ness of the cover. Since abrasives practi always contain moisture they will freeze posed to the weather. Treatment with ride will prevent freezing for a period bu chemical will leach out in time if not in w tight storage and the outer crust, if no whole pile, will freeze. This effect ca minimized by spreading dry chloride ove top of the stockpile.

LOADING OF ABRASIVES

Speed is the essential factor in succe treatment of icy pavements. Every must be made to load, haul, and apply th rasives as quickly as possible. Loading p

hould be so located that the trucks will spend he least possible time enroute. Hand loading es up the trucks when they should be out on he road. Loading from bins is the preferable ethod with the use of a shed and loader com- ination as next best. If it is impossible to use echanical loading entirely, the trucks should e so distributed that only small trucks will be and loaded.

When abrasives are stored at commercial lants and loaded with the plant equipment he facilities must be provided on a 24-hr. asis.

PREPARATION OF SURFACE

Before treating a road surface with ab- sives or chemicals to prevent skidding on icy rfaces, the snow or loose ice should be re- oved as completely as possible. Plowing ith snow plows or blade graders is the usual actice.

An effective method of preparing the surface by scoring the ice or packed snow with a w-tooth blade. The purpose is not to re- ove the ice but to roughen it in preparation r treatment with abrasives or chemicals. he loosened ice or snow should be removed as on as possible with conventional plowing ades.

APPLICATION OF ABRASIVE

uantities

An application of ½ lb. to 1 lb. of treated nd or cinders per square yard will give a od cover and should make the road non-skid it is uniformly distributed. When traffic wind has whipped off the material it may be ecessary to re-cover some sections, especially grades, curves and intersections.

quipment

A conventional three to five-ton truck with mechanical spreader is the most desirable uipment for ice treatment. However, any pe of truck with a dump body can be used cluding four-wheel-drive plowing units. preaders should be installed on each piece of ow removal equipment that is equipped with dump body.

Speed of discharge and uniformity in dis- ibution are the important functions of a tisfactory spreader. There are two general pes of spreader; one is attached to the truck and the other is on a trailer. Power may be obtained from a belt driven by the rear wheels of the truck, from a separate motor, or from a wheel attached to the spreader and driven by contact with the road surface.

One efficient spreader consists of a 6-cu. yd. trough-shaped hopper in place of the conventional truck body. The abrasive material is fed uniformly to the spreading mechanism by means of a screw conveyor. The control mechanism of this unit is in the cab and it is unnecessary to have a man riding on the body of the truck. This unit is operated by a separate gasoline motor.

Ample illumination of equipment should be furnished for safety at night. A distinctive group of cluster lights should be placed on all

FIG. 1.—Mechanical Sand Spreader in Operation.

sanding and snow removal equipment. Reflectors should be provided on the rear of the cab, the rear of the body, and if necessary, on the spreader. Removable hand rails should be provided for the sides of the body to protect the men. Lanterns or other warning lights should be hung from the tailgate. A flashing red light with a ten-inch lens mounted on a telescopic bracket and attached to the left rear of the cab should be standard equipment on all plowing and sanding units.

APPLICATION OF CHLORIDE WITHOUT ABRASIVE

Another method of ice control now being tried is the application of dry chloride directly to the road surface. There is often a period immediately following a snowstorm when the temperature is at its highest level before falling. During this period there is a considerable amount of moisture both in the air and on the road surface. At this time application of from 300 to 500 lb. of sodium or calcium chlo-

ride per mile of two-lane roadway spread for about two feet along the center line will form a solution which will prevent the formation of ice. Under severe conditions it might be advisable to use chloride up to 0.5 lb. per sq. yd. distributed over the entire roadway width.

The chloride can be applied through the regular spreader if the truck travels fast enough and the discs are detached. It also can be spread directly through the tailgate. A special dispenser can be made using a funnel-shaped metal hopper at the elevation of the back of the truck with a 2-in. iron pipe running to a flared plate set about 9 in. from the road surface.

This method is particularly adaptable during sleet or light snow storms which occur when the temperature is just below fre and continues thus for some time.

TREATMENT OF PORTLAND CEMENT CONCRETE

Calcium or sodium chloride treated rasives or these chlorides used alone shou applied as sparingly as possible to por cement concrete pavements. This is be repeated freezings and thawings of concr contact with these salts may be conduc surface pitting or scaling.

Unscaled pavements over 4 years old; that have been given protective surface ments; those made from portland cement taining air entraining agents or those which air entraining agents were introduc the mixer are relatively free from this da

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WARTIME ROAD PROBLEMS

No. 1. Curing Concrete Pavements Under Wartime Restrictions on Critical Materials.
No. 2. Design of Highway Guards.
No. 3. Design of Concrete Pavements Requiring a Minimum of Steel.
No. 4. Maintenance Methods for Preventing and Correcting the Pumping Action of Co Pavement Slabs.
No. 5. Granular Stabilized Roads.
No. 6. Patching Concrete Pavements with Concrete.
No. 7. Use of Soil-Cement Mixtures for Base Courses.
No. 8. Thickness of Flexible Pavements for Highway Loads.
No. 9. Treatment of Icy Pavements.

IN PREPARATION

Salvaging Old High Type Flexible Pavements.
Compaction of Subgrades and Embankments.
Soil-Bituminous Roads.